LIV.—*On the* Hexactinellidæ *and* Lithistidæ *generally, and particularly on the* Aphrocallistidæ, Aulodictyon, *and* Farreæ, *together with Facts elicited from their Deciduous Structures, and Descriptions respectively of Three New Species.* By H. J. Carter, F.R.S. &c.

[Concluded from p. 373.]

Let us now turn our attention to the Lithistidæ, of which the following is a similar list of those also that have been brought to notice.

Lithistidæ*.

General character. Spicules developed upon a quadriradiate division of the central canal, held together by amorphous sarcode and an interlocking of their filigreed arms, forming a reticulated glassy structure, whose interspaces are more or less irregular and curvilinear. Composed of two kinds of "skeleton-spicules," viz. those which form a layer on the surface and are accompanied by minute or "flesh-spicules" characterizing the species, and those forming the body, which are more or less alike in all the species and accompanied by fewer flesh-spicules. The skeleton-spicules of the surface, which, for the most part, are provided with a smooth, pointed, vertical shaft, directed inwards, and a horizontal head of different shapes according to the species, will be termed "surface-;" and the spicules of the body, which interlock with their neighbours through a filigreed development of all the arms, will be termed "body-spicules."

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Species in which the surface-spicule consists of a shaft and three straight bifurcated arms all smooth and pointed.

Minute spicules of two kinds, viz. one acerate, fusiform, slightly curved and microspined; the other subspiral, sinuous, tuberculo-spined.

Dactylocalyx Bowerbankii, Johnson. Azores. (1)
—— *Masoni*, Bowerbank. Madeira. (2)
Corallistes typus, Schmidt. Florida. (3)

* Abbreviations the same as in footnote, p. 357.

1. B.M. P. Z. S. 1863, p. 259,=P. Z. S. 1869, p. 94, pl. vi. figs. 6, 7, & 8, =*MacAndrewia azorica*, Gray, P. Z. S. 1867, p. 507.
2. P. Z. S. 1869, p. 91, pl. vi. figs. 1–4.
3. Atlantisch. Spongienf. pl. iii. f. 3.
4. B.M. P. Z. S. 1868, p. 565, fig. 1.
5. P. Z. S. 1869, p. 89, pl. v. figs. 6–11.

Species in which the surface-spicule consists of a shaft and three sinuous arms branched.

Minute spicules of two kinds, viz. one long, fusiform, subspinulate, smooth; the other short, more or less bent or horse-shoe-shaped and microspined.

Theonella Swinhoei, Gray. Formosa. (4)
Dactylocalyx Prattii, Bk. East Indies. (5)

Species in which the surface-spicule consists of a shaft and three sinuous arms compressed vertically; branched and dentate or curvilinear on the margins.

Minute spicule acerate, fusiform, curved, microspined.

MacAndrewia azorica, Gray. Azores. (6)
= *Corallistes clavatella*, Schmidt. Florida. (7)
Kaliapsis cidaris, Bowerbank. South Seas. (8)

Species in which the surface-spicule consists of a short shaft and subcircular discoid head, deeply and irregularly fissured.

Minute spicule acerate, fusiform, curved, blunt-pointed? microspined.

Corallistes polydiscus, Schmidt. Portugal, Florida, Cuba. (9)

Species in which the surface-spicule consists of a short shaft and subcircular discoid head.

Minute spicule acerate, fusiform, curved, microspined.

Dactylocalyx polydiscus, Bowerbank. St. Vincent, Portugal. (10)

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6. B.M. P. Z. S. 1859, p. 438, pl. xv. *Dactylocalyx McAndrewii*, Bk. P. Z. S. 1869, p. 86, pl. iv. fig. 5.
7. Atlantisch. Spongienf. pl. iii. f. 7.
8. P. Z. S. 1869, p. 338, pl. xxv. figs. 2 & 5.
9. Atlantisch. Spongienf. 1870, p. 24, pl. iii. figs. 8 & 9.
10. B.M. P. Z. S. 1869, p. 96, pl. vi. figs. 10–14. *Discodermia polydiscus*, Bocage, 1869, Journ. des Sc. Math. Phys. et Nat. Lisbonne, No. iv. pl. xi. fig. 1, &c.
11. B.M. See p. 442.
12. See p. 443.
13. Atlantisch. Spongienf. p. 23, pl. iii. fig. 6, &c.
14. *Ib.* p. 23, pl. iii. fig. 4.
15. *Ib.* p. 23, pl. iii. fig. 5.
16. *Ib.* p. 22, pl. iii. fig. 1.
17. *Ib.* p. 21, pl. iii. fig. 2.
18. See p. 443.

Species in which the surface-spicule consists of a shaft and three arms. Arms sinuous, branched, curvilinear, tubercled on the upper or outer aspect, and filigreed at the extremities; shaft filigreed also at its extremity.

Minute spicule long, slender, fusiform, subspinulate, smooth, most numerous on the margin, where it forms a fringe.

Azorica Pfeifferæ, Carter. Azores. (11)

Species in which the surface-spicule is much the same as the last, but with others like those of Dactylocalyx Bowerbankii *and* D. polydiscus *among the body-spicules.*

No minute spicule observed.

Corallistes borealis, Carter. Färoe Islands. (12)

Species in which the surface-spicule consists of a long shaft and three arms, bifurcated and more or less tubercled on the outer or upper aspect.

Minute spicule (in the slide at the British Museum) straight or slightly curved, smooth, fusiform, acerate.

Corallistes noli tangere, Schmidt. Portugal, St. Jago. (13)

Species in which the surface-spicule (according to the slide in the British Museum) is like that of Dactylocalyx Masoni, *with the branches of the body-spicules in like manner glomerato-tubercled.*

Minute spicules in the slide of two kinds, viz. one acerate, fusiform, curved, smooth; and the other with sinuous shaft, spirally covered with fine spines like that of *D. Masoni*.

Corallistes microtuberculatus, Schmidt. St. Jago, Cape-Verde Isl. (14)

Species in which the surface-spicule (according to the slide in the British Museum) is like that of Dactylocalyx Bowerbankii; *the rest with large filigreed head and long sinuous shaft filigreed at the extremity, as in the figure* (Atlantisch. Spongienf. Taf. iii. f. 5).

Corallistes elegantior, Schmidt. Portugal. (15)

Species with curly filigreed spicules (according to the slide).

Leiodermatium ramosum, Schmidt. Florida. (16)

—— *lynceus*, Schmidt. Portugal. (17)

Fossil species in which the surface-spicule is not known, but in which the body-spicule has the common branched filigreed form.

Minute spicule not observed.

Lithospongitis Kittonii, Carter. Carrow, hamlet adjoining Norwich. (18)

Short Commentary on the Lithistidæ.

The remarks regarding the microscopical examination of the Hexactinellidæ (see p. 363) apply to the Lithistidæ; but while the two large specimens respectively of *Dactylocalyx pumiceus*, Stutchbury, and *MacAndrewia azorica*, Gray, in the British Museum, are very much alike in their dish-shaped, wide, circular heads, each of which is supported by a thick short stem, and their minute structure has the same vitrified glassy appearance, it should be remembered that they form representatives of two totally different systems of sponges, the former being built upon a sexradiate division of the spicule, and the latter upon a quadriradiate one; that is, while the Hexactinellidæ have six ends to their spicule, the Lithistidæ have only four, and the lowest system of spicules in which the linear form prevails, of course, only two. Hence the spicule of the Hexactinellidæ has, as it were, three shafts joined together in the centre, thus giving six ends; the next, or quadriradiate system, has, as it were, two shafts joined together in the form of a cross, thus presenting four ends; while the simplest system of all has only one shaft, and consequently only two ends. Thus modified, forms of all the three systems may be found in the Hexactinellidæ; but only those of the third system with the Lithistidæ—that is, no sexradiate spicules. Of course I allude to the staple spicules here, and not to the monstrosities which may occur in either system; and perhaps, too, I should restrict these observations to the spicules of the skeleton-system, or skeleton-spicules, since, when we come to the minute or flesh-spicules, we find the multifid form of the sexradiate spicule, viz. that of the rosettes, passing, as before stated, into the stellates and globular siliceous balls of the Geodinidæ &c., and of course *vice versâ*.

But, be this as it may, there seems to be very little doubt that the system of the Lithistidæ is that of *Pachastrella*, *Geodia*, and *Stelletta*, and never that of the Hexactinellidæ: that is, a sexradiate spicule, as just stated, is never found in the Lithistidæ.

In *Dactylocalyx Bowerbankii* and *D. Masoni* the surface-spicules are nail-like, having the spike or shaft directed inwards and the three arms of the head bifurcated and spread out horizontally, so as to meet those of the other surface-spicules, while the interspaces are occupied by the sarcode charged with the flesh-spicules, in the midst of which are the pores; and thus the dermal aspect is completed. In *D. Masoni* the subspiral shaft of the minute or flesh-spicule is covered

with fine, pointed, long spines, while in *D. Bowerbankii* they are short, blunt, and slightly inflated at the ends; again, the acerate spicule in the former is not figured (Bk. Monogr.), while the fine-spined subspiral spicule of *D. Masoni* seems to be only a variety of the more coarsely formed one in *D. Bowerbankii*; and the acerate spicule, being also very sparse in the latter, may have been entirely overlooked in the former. Thus, at the utmost, *D. Masoni* can only be considered a variety of *D. Bowerbankii*. The secondarily furcate extremities of the arms of the surface-spicule in Dr. Bowerbank's fig. 7 of *D. Bowerbankii* (*l. c.*) at once allies it to similar forms of the spicule in *Pachastrella abyssi*, Sdt., and points out the commencement of the filigree which becomes so elaborately developed as the surface-spicules gradually sink into the general structure of the body. Schmidt's *Corallistes typus* would, therefore, come in here.

In *Theonella Swinhoei* and *Dactylocalyx Prattii*, the arms of the surface-spicules are not straight but sinuous, and, thus overlapping each other, leave circular interspaces which are filled up with sarcode charged with the flesh-spicules, in the midst of which are the pores. The minute, cylindrical, microspined spicule varies much in form, from an elongated ellipse to that of a horseshoe-shaped, cylindrical, linear spicule, being also sometimes contracted in the centre and enlarged towards the extremities.

In *MacAndrewia azorica* and *Kaliapsis cidaris* the arms of the surface-spicule, besides being sinuously branched, are also flattened, and possess a dentate curvilinear margin on both sides, while the branches overlapping each other, as before stated, leave interspaces that are filled with sarcode charged with the rough, microspined, acerate spicule mentioned, in the midst of which are the pores. These minute linear spicules, often slightly inflated in the centre, are arranged around the pores in a radiated manner, so that the pore can be opened or closed by their being raised or the reverse. The structure is well represented by Schmidt in *Corallistes clavatella* (*op. cit.* pl. iii. fig. 7, *b*), which appears to be equal to *MacAndrewia azorica*. I possess fragment-specimens of *MacAndrewia azorica* which were dredged up on board H.M.S. 'Porcupine' between the Färoe Islands and the north coast of Scotland. Unfortunately the specimen of *Kaliapsis cidaris* which Dr. Bowerbank found on a portion of *Oculina rosea* from the South Seas was so small that it was "all" absorbed in the mounting and examination.

In *Corallistes polydiscus*—better designated "*asteroides*" by Schmidt on the slide which he sent to the British Museum,

seeing that this, as well as his figure (*op. cit.* pl. iii. fig. 8), has a discoidal head so deeply fissured as to merit the term mentioned—we seem to have in the surface-spicule a transitional form from the three- flat armed head of that in *MacAndrewia azorica* to that of the subcircular form in the following species, viz. *Dactylocalyx polydiscus*, where the discoid head is so little fissured as to merit this designation. How far these forms may run into each other in the same species I am ignorant, as I have only examined *D. polydiscus*, in which *all* the heads are subcircular.

Here I should notice that, in a small rolled fragment of *Corallistes borealis* which I sent to Mr. F. Kitton, of Norwich, to compare with the fossil species to be presently mentioned, he detected some spicules with subcircular discoid heads, like those of *Dactylocalyx polydiscus*, which he kindly mounted and sent to me; and on them I observe two or three of the minute flesh-spicules common to *D. polydiscus*, but reduced by the process of absorption which takes place in the deciduous vitreous structures of sponges, to be described hereafter, to irregular stick-like forms. Now it so happens that with Schmidt's fig. 8 of the surface-spicule of *Corallistes polydiscus* there are also two of these irregular stick-like forms represented, which I never could understand until Mr. Kitton sent me the mounted specimen mentioned. Hence it seems to me, from their imperfect form, that Schmidt's minute or flesh-spicules at least belonged to a deciduous skeleton.

As just stated, the heads of the surface-spicules in *Dactylocalyx polydiscus* are discoid and subcircular. The shaft is short, smooth, and pointed; and where it joins the disk a triradiate line is seen, which results from the division of the central canal of the shaft into three branches. The discoid heads as usual overlap each other; and the dermal sarcode is charged with the minute flesh-spicule already mentioned; while in the interspaces between the heads are the pores. The triradiate line is often seen in this kind of spicule in the Lithistidæ, where also the minute, acerate, fusiform, microspined flesh-spicule is also very common.

In *Azorica Pfeifferæ*, n. sp. (two specimens, called after Madame Ida Pfeiffer, who obtained them at Madeira and presented them to the British Museum), the surface-spicule is like that of the interior, viz. with the sinuously branched arms and shaft all terminating in filigreed structure, that of the shaft interlocking with that of the heads of the next layer inside it. There is no very minute flesh-spicule, but a great number of long, subspinulated, fusiform, linear ones, which abound

especially upon the growing edge or margins of the specimen. The specimens are covered with dried sarcode, evidencing that they were taken alive and may so far be considered perfect. Hence there is no doubt about their possessing no characteristic surface-spicule; for I searched for this in many parts. Still I think it just possible that this may be explained by assuming that the surface-spicule had passed into the form of the body-spicule before the new layer of surface-spicules had been developed.

Be this as it may, the specimens are magnificent and magnificently perfect; not, perhaps, from any particular care having been bestowed on their preservation, but because, contrary to what one would infer from their glassy structure, they are so tough that it is difficult to get a piece off them. One is 14 inches in diameter and 11 inches high, and the other not quite so large. They are flattish, cabbage-like, infoliated, with branched sinuous laminæ $\frac{2}{12}$ to $\frac{2}{8}$ inch thick, vertical, widely separated, and proliferous. The vents are a little raised on papillary eminences, and scattered over the *inner* aspect of the fronds or laminæ; while the pores are *outside*, as in *MacAndrewia azorica*, to which it bears a strong general resemblance. My reason for stating all these characters is because these specimens have hitherto not been described.

Corallistes borealis is the name which I have given to deciduous fragments of a Lithistid dredged up on board H.M.S. 'Porcupine' between the Färoe Islands and the north coast of Scotland. They have no characteristic surface-spicule; and in their body-structure are confusedly mingled both the simple form of surface-spicule characterizing *Dactylocalyx Bowerbankii* and that of *D. polydiscus* respectively. Various other sponges have built their structures upon them, among which is that possessing the snake-like form of large acerate spicule figured by Schmidt in connexion with his representation of *Corallistes typus* (*op. cit.* pl. iii. fig. 3 *c*), which of course is also parasitic. How to account for the surface-spicules before mentioned occurring among the body-structure of *Corallistes borealis* I know not.

For the structure and form of the remaining Lithistidæ and their spicules, I must refer the reader to Schmidt's work on the Atlantic sponge-fauna, already mentioned, where they are respectively described and figured.

I would, however, for a moment more here revert to the fossil species *Lithospongitis Kittonii*, which Mr. F. Kitton, of Norwich, found in a flint of the Upper Greensand taken from an artesian well at Carrow, close to Norwich, to observe

that we have here *en masse* what my illustrations of the fossil spicules of the same geological formation on Haldon Hill, near Exeter, show in individual spicules (Annals, 1871, vol. vii. pls. vii. & viii.). Thus the existence of such sponges in the Upper Greensand had been predetermined.

Observations.

The above arrangements of the Hexactinellidæ and Lithistidæ, together with the short commentaries which follow them respectively, must be regarded only as preliminary to more detailed descriptions which I hope to offer on some future occasion. They are chiefly intended as an introduction to what will hereafter be stated of the *Aphrocallistidæ*, *Farreæ*, and *Aulodictyon*, concerning which I had, as before stated, gathered many facts for publication hitherto unnoticed, when I found it necessary to make myself acquainted with all the Hexactinellidæ and Lithistidæ that had been made known before I could satisfactorily acquit myself of the task.

This involved much time and much research, combined with opportunities which may not readily occur again. Hence I thought it desirable to record at once the most important part of my observations, although this is not the place to give the whole, which would entail long descriptions.

Object.

We now come to the primary object of this paper, which was to show that the tubular lines which appear in the vitreous fibre of the Hexactinellidæ arise from the absorption of the spicules on which it was originally deposited—that if this has not gone too far, the exact forms of these spicules can be recognized; so that, although nothing else but the deciduous fibre remains, the species of the sponge to which it belonged can thus be determined if previously known in the living state—and if not previously known in the living state, then also the kind of spicules it must have possessed in this condition. The deciduous specimens of Hexactinellidæ which will come before us for this purpose belong to *Aphrocallistes Bocagei* and *Farrea occa*, of which the living state of the former is well known, but the deciduous skeleton *only* of the latter. Meanwhile, for the sake of reference, it will be necessary to premise a short account of each of the specimens from which my observations have been derived; then a description of each of the spicules of the species of Hexactinellidæ with which we are now chiefly concerned that have been found in a living state, viz. the *Aphrocallistidæ*, *Aulodictyon*, and the *Farreæ*; and,

lastly, a description of the deciduous skeleton of *Farrea occa*, and the destructive changes which take place in the sponge-spicule generally, followed by the absorbing process in the vitreous fibre of the deciduous Hexactinellidæ to which I have often above alluded.

Short Descriptions of Specimens that will presently come under reference.

The first of the specimens that came under my observation in this respect was one of the so-called *Farrea occa*, which, having grown upon a branched coral (*Lophohelia prolifera*), subsequently became overgrown, both sponge and coral, by a *Gummina* (*Corticium abyssi*), so as to form a solid mass, through whose smooth surface here and there projected portions of both sponge and coral. This specimen, I learn from the label on the glass jar containing it, was dredged up on board H.M.S. 'Porcupine,' in lat. 43° 31′ N., and long. 10° 3′ W. (that is, in the so-called "*chops*" of the English Channel), in 500 fathoms. It is now an oblong portion, in size about $2\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{4}$ inch, which originally must have been larger, as there are many fragments of it in the same jar. The specimen is figured in the 'Annals' for July 1873, pl. i. figs. 1 & 2, of the natural size; and to this specimen or figure I shall often have to allude as "No. 3 *a*," which heads the label on the jar. All this may seem unnecessarily particular; but as the specimens of Spongiadæ dredged up on board H.M.S. 'Porcupine' have been handed over to me by Prof. Wyville Thomson for description, every thing that tends to point out their history should be recorded.

By the term "so-called *Farrea occa*," I mean that this name was given to a simple fragment of vitrified network, found in great abundance in the detrital mass on which Dr. Farre's specimen of *Euplectella cucumer* had grown. "Simple," because the fragments are those of dead sponges, and therefore without sarcode, while the minute spicules which accompanied them, and are figured by Dr. Bowerbank as the "retentive spicules" of *Farrea occa* (*l. c.*), are not those of a sexradiate sponge, which the fragments are, but of an undescribed species of *Gummina*. How far the form and structure of this sponge, to which the fragment figured by Dr. Bowerbank (fig. 7, *l. c.*) belonged, has been subsequently discovered, the sequel of this paper will show. Suffice it now to state that we shall take as the characteristic feature of Dr. Bowerbank's *Farrea occa* the rectangular latticed "harrow-like" structure of his illustrations (*l. c.* pl. xxiv. fig. 7, 1869), first represented by Prof. Owen in connexion with *Euplectella cucumer* (Trans. Linn. Soc. 1857,

vol. xxii. pl. xxi. fig. 9 & 9*a*), and not Dr. Bowerbank's figure 1, which we shall hereafter find to belong to *another* species of *Farrea*, also illustrated by Prof. Owen (*op. cit.* fig. 8). In short, a cursory inspection of the two figures in Dr. Bowerbank's plate will show that they belong to two different structures, one of which (viz. fig. 7) has smooth, and the other(fig. 1) spiniferous fibre. The former we shall call "*Farrea occa*," and the latter "*Farrea densa*."

At the time Dr. Bowerbank described *Farrea occa* (P. Z. S. p. 339, 1869), the only thing known of it was the fragment mentioned; hence it is not surprising that his description should, to say the least of it, be very different from reality. We now know that this smooth rectangular fibre belonged to a branched, tubular skeleton, only one layer thick, and the branches patulous at the ends, which, up to this time, appears to have been found only in a deciduous state; so that we do not know even now what were the forms of the spicules on which the fibre was originally deposited, except through the means already stated, viz. the absorption of these spicules, which takes place only in the deciduous skeleton, reducing their forms to mere moulds, which, however, represent their true forms inside the fibre. Can we find, then, sufficient of these forms enveloped in the deciduous fibre to tell us what the living species possessed? will be the question by-and-by, when we come to consider *Farrea occa* more particularly.

The next specimen which I have had for observation is that of a dead *Aphrocallistes Bocagei* in a jar without label; but finding only one place where this sponge is mentioned in the "Preliminary Report of H.M.S.'Porcupine,'" published in the Royal Society's 'Proceedings' (No. 121, p. 424, 1869), where it is stated that a "tolerably perfect though dead specimen of *Aphrocallistes Bocagei* had been dredged up at Station 36 in 725 fathoms with a bottom of muddy sand," I presume that it is the one in question, which consists of a hollow cylindrical tube, composed of vitreous network, closed at the free end by the same structure in a convex form, and terminated at the other by a flat disk, which adhered to the object on which it grew, covered with buds or shorter tubes of a like kind, whose cavities respectively are continuous with that of the main tube or stem, the whole specimen being about two inches long and one in diameter. This "Station," I see by the table, was in lat. 48° 50′ N., and long. 11° 9′ W.; so that it was dredged up close to the specimen of *Farrea occa* just mentioned. We will designate it by the "Station," viz. "No. 36."

From the deep-sea specimens of H.M.S. 'Porcupine,' let us go to those in the British Museum dredged up on board

Mr. Marshall Hall's yacht 'Norna' in 1870, on the N.W. coast of Spain and Portugal, by Mr. Saville Kent; and here we shall find a dead specimen of *Aphrocallistes Bocagei* now broken into pieces, but when entire a little larger and of the same kind as that last described,—also a dead specimen of *Farrea occa*, consisting of a bunch of short tubes slightly trumpet-shaped and open at their free ends, branching off from a main axis (Month. Microscop. Journ., Nov. 1870, pl. lxiv. fig. 12), both dredged up from a muddy bottom, and both filled with the mud.

Further, on a bunch of dead *Lophohelia prolifera*, there is another small but living specimen of *Aphrocallistes Bocagei*, together with several young or embryonic specimens here and there on the branches of the former, some of which are not more than $\frac{1}{32}$ of an inch in diameter, which, on microscopical examination, present the spicules of *Aphrocallistes Bocagei*, that at the same time are identical with those figured by Schmidt (*l. c.*) as illustrative of his *Lanuginella pupa*, which, as may be observed by his figure of *Aphrocallistes Bocagei* (*op. cit.* pl. ii. fig. 1), grew in great numbers on this specimen.

Lastly, on one of the branches of the same bunch of *Lophohelia prolifera* may be observed the unique specimen of *Aulodictyon Woodwardii*, discovered, described, and figured by Mr. Kent (*op. et l. cit.*). It also, like *Farrea occa*, is a tubular structure of rectangular lattice-like vitreous fibre, but otherwise appears to have been branched and closed at the extremities like *Aphrocallistes Bocagei*; still the specimen is so small, being not more than half an inch long, and the ends of the branches are so broken off, that, with the exception of its growing from a branch of the *Lophohelia* like *Farrea occa* (that is, spread out and not attached by a disk-like end like *Aphrocallistes Bocagei*), nothing more can be said of its general form.

Lastly, I have to notice a deciduous specimen of *Farrea occa*, about the same size and form as that last-mentioned, which was dredged up from the Caribbean Sea in about "lat. 14° 2′ N., and long. 77° 42′ W., in 1500 fathoms," and submitted by Mr. Gassiot (to whom the vessel belonged whose captain obtained it) to Dr. Gray, and by the latter to myself for examination. It is also much broken, but measures an inch long by about the same in transverse diameter. Also, from the same locality, a little stick-like fragment about $1\frac{1}{2}$ inch long and $\frac{1}{4}$ inch broad, composed of vitreous fibre like that of *Farrea*, but solid, bleached, and rounded in its contour, which is rendered very irregular by a dissolving action that has been going on in the fibre both inside and out for some time; and three specimens of a new species of *Farrea*, which was funnel-

shaped, to the solid stem of which stick-like fragment the foregoing specimen appears to have considerable resemblance.

As the latter constitutes the type of a new species of *Farrea*, some specimens of which were taken in the living as well as in the deciduous state, it is necessary, for future reference, to give a particular description of it at once, which will now follow under the designation of "*infundibuliformis*."

Farrea infundibuliformis, Carter, n. sp. Pl. XVII. figs. 1–4.

Vitreo-hexactinellid. Infundibuliform, consisting of a head (fig. 1, *a*) and stem (fig. 1, *b*). Stem subround, solid, composed of interlacing, branched, mixed with rectangular lattice-like fibre. Head funnel-shaped, formed of an expansion of the stem composed of a layer of rectangular lattice-like fibre in the centre (fig. 2, *b b*), covered on each side by one of branched vitreous fibre, whose branches diminish in size as they increase in number towards the circumference (fig. 1, *c*, 2, *a a*); reticulated and anastomosing obliquely throughout. Rectangular fibre strongly spined and formed of an extension of vitrified sarcode over a regular rectangular arrangement of large sexradiate spicules. Branched fibre minutely spined (fig. 2, *c c*), and more or less charged with minute sexradiate spicules, smooth and pointed or spined along the arms and at the ends, confusedly arranged (fig. 1, *d d*, & fig. 3), some of which are only partially enveloped, and others only cemented by one end (fig. 3, *a*) to the fibre. Interstices lined with sarcode charged with rosettes. Rosette many-rayed; rays sigmoid, capitate, expanded and arranged *en fleur-de-lis* (fig. 4); head of ray convex, spined round the margin. *Size*: diameter of funnel-shaped head about an inch, depth about $\frac{4}{12}$; thickness of wall at the margin, which is broken, $\frac{1}{18}$ inch; length of the portion of stem remaining $\frac{4}{12}$; diameter of the same close below the head $\frac{2}{12}$ inch.

Hab. Marine.

Loc. Caribbean Sea.

Obs. There are three specimens of the vitreous skeleton of this sponge in the British Museum, all about the same size and shape, but all more or less imperfect on the margin of the funnel-shaped expansion, which, being very thin, has no doubt been broken away by the dredge or "tangle" in which the specimens were taken. The stem in each also appears to have been broken off at the end, where it was just branching into three or more divisions, as if these divisions had terminated in the roots by which the sponge had been attached to some submarine object, and from which the specimens respectively had been broken off by the dredge or tangle.

Besides the specimens mentioned, there are two other thin flat portions, each of which is about an inch square and $\frac{1}{24}$ inch thick, which, presenting no visible curvature, may have belonged to infundibuliform heads of much larger dimensions than those above given. It is not improbable too, from the extreme thinness of the margin of the expansion of the more perfect specimens, that, if the heads in them respectively had been entire, their diameter would also have been greater. The flat portions must have been broken off from living specimens, as they are covered with dry sarcode abundantly charged with the form of rosette above mentioned.

This differs from *Farrea occa*:—1st, in the addition to the single lattice-like layer of which *Farrea occa* is composed, of a much larger, obliquely anastomosing, branched, vitreous fibre, apparently originating, both outside and in, from the bottom of the funnel-shaped expansion where it is thickest; 2nd, in this fibre being charged with the *minute* sexradiate spicules of the species, *confusedly* imbedded, entirely or partially (that is, in various degrees), within its substance; 3rd, in these sexradiates being much smaller than those singly and *regularly* arranged in what appears to be the basework or original lattice-like fibre of a *Farrea occa*. In short, the branched anastomosing fibre charged with the minute sexradiate spicules appears to be a secondary formation, which has run over a rectangular fibre vertically, so that it cuts the transverse bars of the latter, although amalgamating with them here and there at right angles.

Spicules of the *Aphrocallistidæ*, *Aulodictyon*, and *Farrea facunda*.

We now come to the description of the spicules respectively of the *Aphrocallistidæ* and *Aulodictyon Woodwardii* in their living state, together with a species of *Farrea* described by Schmidt as *F. facunda* (*fecunda*?), with all of which it will be found necessary that we should become acquainted before we can make out any thing of those in the deciduous skeletons.

Aphrocallistidæ.

Aphrocallistes beatrix, Gray, and *A. Bocagei*, Wright.

These two sponges have been excellently described and illustrated by the naturalists respectively who named and brought them into notice. But only generally. The detail of their spicules has not been sufficiently given; and as it is necessary that this should be minutely done, in connexion with illustrations, before their histories respectively can be considered

complete, as well as for the purpose of identification just mentioned, we will direct our attention for a few moments to this part of the subject.

Aphrocallistes Bocagei.

Taking *Aphrocallistes Bocagei* first, as this is the simplest form, it will be found that, besides the common large sexradiate spicule on which the vitreous structure is based, there are seven other kinds attendant upon it, all of which are more or less free and unimplicated in the vitreous sarcode, viz. :—

1. The staple, *linear*, fusiform spicule with inflated centre and extremities, in which the former presents 2–4 tubercles more or less developed opposite corresponding branches of the sexradiate central canal; extremities more or less pointed and spined.

2. A more delicate, *linear*, fusiform spicule, spined throughout. The spines long and slender, supported on projections of the shaft resembling the bracket-steps of a flagstaff; more or less closely inclined towards the shaft, and *all* in the *same direction*—that is, not half one way and half the other, beginning from the centre of the shaft and proceeding in opposite directions, but from one end towards the other throughout. As this is a very common form in the Hexactinellidæ, and the other kind also exists occasionally, viz. that in which the spines are inclined towards either point beginning from the centre, it is necessary to note the difference and give particular attention to the form chiefly under consideration (Pl. XV. fig. 8).

3. A sexradiate spicule whose arms are more or less unequal in length—five being smooth at the commencement and conically inflated and spined at the termination, and the sixth spined, feather-like all round, the spines increasing in length from the fixed to the free end. Sometimes, in an abnormal state, more than one of the arms is thus spined (fig. 9).

4. A scopuline spicule, consisting of a long shaft and four rays. The rays more or less divergent, arising from a corresponding number of tubercles at the end of the shaft, and terminating in conical heads surrounded with recurved spines. The rays are microspined and the end of the shaft also. Frequently the shaft presents a quadriform inflation just below the giving off of the rays; and sometimes the little tubercle in the centre of the four rays, which is the end of the shaft, is prolonged into a fifth ray (figs. 1 & 1 *d*).

5. A rosette with five-rayed arms, each ray straight or slightly sigmoid, and all divergent and capitate, except the central one, which is in a line with the arm; head of the ray convex and spined round the margin more or less deeply

(fig. 11, *d*). An abnormal form of the rosette is to have the arms continued respectively into one large ray.

6. The same, but with the axis stretched out linearly, shaft-like, and the rays arranged round it more or less spirally; rays long, spine-like, capitate, most numerous at the ends, where they are more or less divergent (Pl. XIII. fig. 17).

7. The same, with the rays of the shaft more confined to its centre, and all simple (that is, *not* capitate, but pointed).

N.B. The last two forms are not near so abundant as the globular rosette (Pl. XV. fig. 11, *d*).

Aphrocallistes beatrix.

We now come to *Aphrocallistes beatrix*, in which it will be also found that, besides the common large sexradiate spicule on which the vitreous structure is based, there are six other kinds, viz.:—

1. Similar to no. 1 of *A. Bocagei*, but a shorter, coarser, and more robust form, spined throughout.

2. The same as no. 2 in *A. Bocagei*.

3. A sexradiate spicule whose pointed arms are sparsely and irregularly covered throughout with smooth spines curved outwards, and longest about the union of the middle with the inner third, diminishing towards the extremities of the arms (Pl. XV. fig. 10). This appears to be the analogue of no. 3 in *A. Bocagei*, since I have never seen the sexradiate spicule with feather-like spined arm in *A. beatrix*, nor has Mr. Kent, who also states this, and that the one figured in his illustration of this sponge is taken from Dr. Bowerbank's (P. Z. S. 1869, pl. xxii. fig. 3). If, however, Dr. Bowerbank has been more fortunate in this respect, his figure shows, by the abortive condition of the spines on the feathered arm of this spicule in *A. beatrix* compared with that in *A. Bocagei*, that this spicule is very poorly, and therefore perhaps very sparsely, represented in *A. beatrix*.

4. A scopuline spicule, consisting of a long shaft and four rays; the rays quadrangularly based on a hand-like expansion of the end of the shaft; for the most part proceeding for some distance almost parallel to each other, when they end by becoming slightly divergent, terminating respectively in small, smooth, round heads, surrounded by recurved spines. The rays and the end of the shaft also microspined throughout (Pl. XV. fig. 2).

5. A straight large shaft more or less beset with long, thorn-like spines, most numerous towards the centre, where they are vertical, and at the extremities, where they are divergent; each slightly curved and microspined (Pl. XIII. fig. 20).

6. A smaller kind, in which the rays are straight, smooth, and capitate (Pl. XIII. fig. 19). This, which has also been figured by Mr. Kent (Month. Microscop. Journ. 1870, no. 33, pl. lxv. fig. 20), is analogous to no. 6 in *A. Bocagei*, and thus becomes a transitionary form of the rosette in the latter to the large, spined shaft no. 5 (just described) peculiar to *A. beatrix*, in which sponge there is no rosette; that is, the globular rosette in *A. Bocagei* first presents itself in that sponge with elongated shaft-like axis and pointed or capitate spines, which form is again found, *without* the globular rosette, in *A. beatrix* apparently leading to the large spined shaft that is as characteristic of this species as the globular rosette is of *A. Bocagei*.

Obs. About the bunch of dead *Lophohelia prolifera* dredged up by Mr. Kent there are, as before stated, in addition to the larger specimens of *Aphrocallistes Bocagei* and *Aulodictyon Woodwardii*, several embryo sponges; and two of these (viz. one $\frac{1}{24}$ and the other about $\frac{2}{12}$ of an inch in diameter) I mounted in Canada balsam, when it was observed that they both belonged to *Aphrocallistes Bocagei*; but while the vitrified fibre had not begun to appear in the former, it had in the latter, where several sexradiate and linear spicules had become cemented together, involving also some of the sexradiates of *Aphrocallistes Bocagei* with feather-like spined arm (Pl. XV. figs. 9 & 11, *a*, *b*, *c*). At first I took these embryos for *Askonema*; but the sexradiate spicule with feather-like spined arm, together with the vitrification (both of which are absent in *Askonema*), decided this point. Then I remembered that the feather-like spined arm-spicule abounded also in *Sympagella nux*; but the ladder-like forms of the vitreous fibre here, together with the presence of the pappiform rosette with flexed rays, presented a decided difference. Lastly, it was observed that their spicules accorded with those of *Lanuginella pupa*, Schmidt. But when it is remembered that Schmidt's specimen of *Aphrocallistes Bocagei* bore on its surface many specimens of his *Lanuginella* in an embryo state, that their spicules are identical with those of the embryos of *Aphrocallistes Bocagei* on the specimen of *Lophohelia* mentioned, in company also with a fully developed living specimen of *A. Bocagei*, there seems to be very good reason for assuming that *Lanuginella pupa* is neither more nor less than *A. Bocagei* in an embryonic condition.

Aulodictyon Woodwardii, Kent.

In the tube net of *Aulodictyon*, like that of *Aphrocallistes*, there are several other spicules besides the staple sexradiate which forms the basis of the vitreous fibre; and these are also more or less enclosed together with the sexradiates. According

to Mr. Kent (who, as before stated, has the merit of having discovered, described, and illustrated this unique specimen), confirmed by my own observations, they amount to seven, viz.:—

1 and 2. The same as in *Aphrocallistes Bocagei*.

3. An umbrella-like spino-capitate shaft of two forms, one of which has a *large*, flat, convex head, plain or umbonate, with a fringe of minute spines (Pl. XV. fig. 4), and the other a *small* convex head, also plain or umbonate, with a few long recurved spines, microspined on the inner aspect (fig. 5); while between these two extremes this spicule assumes several intermediate forms, in all of which the shaft is pointed, more or less microspined, and of whip-like fineness towards the free extremity.

N.B. This spicule, which appears to be analogous to the scopuline form in the Aphrocallistidæ and that of Schmidt's *Farrea facunda*, from lying parallel with the arms of the large sexradiate skeleton-spicule, often becomes enveloped with them in the vitreous fibre (Pl. XV. figs. 6 & 7).

4. A rosette whose arms are five-rayed; the rays sigmoid, capitate, and somewhat expanded or divergent *en fleur-de-lis*, with the head of the ray round and spined on the margin (like fig. 10, Pl. XIII.).

5. A sexradiate spicule with one arm smooth and inflated, the rest smooth, and terminated respectively by spiniferous points (see Mr. Kent's figure 23, Month. Microscop. Journ. 1870, pl. lxiv.).

6. A sexradiate spicule with one arm spined feather-like, and the rest terminated respectively by spiniferous points (like fig. 9, Pl. XV.).

Nos. 5 and 6 appear to be alternating forms of each other, and analogous to the sexradiate spicule with one arm spined feather-like in *Aphrocallistes Bocagei* &c., but apparently more sparse and less fully developed.

7. A simple minute sexradiate, whose arms may be smooth or spined, attached by one arm to, or more or less enveloped in, the vitrified fibre, as in Pl. XIII. fig. 1.

Obs. These spicules all appear to be analogous to those in *Aphrocallistes Bocagei*; while the umbrella-like ones, lying parallel and close to the arms of the large sexradiate (which forms the basis of the vitrified skeleton), are often, as before stated, enveloped with it (Pl. XV. figs. 6 & 7, *b*). In short, as the sexradiate spicule with feather-like spined arm is seen in the embryo *Aphrocallistes Bocagei* to be becoming enclosed in the vitreous fibre of that species, so the umbrella-like spicules of *Aulodictyon Woodwardii* may be observed on

their way to become enclosed in its vitreous fibre (fig. 7, *b*). Hence may we not infer that the unique specimen of the latter (which is only half an inch in lengh) is a very young specimen also?

Farrea facunda, Schmidt (*fecunda*?).

For a more detailed description of this species, with illustrations, I must refer the reader to Schmidt's 'Atlantisch. Spongienfauna' (1870), merely observing here, for the sake of comparison, that his figure 10, pl. ii., which represents the skeleton of *Farrea facunda* of its natural size, is almost identical in size and form with that figured by Mr. Kent as *Farrea occa* (*l. c.*), with that in my possession from the dredgings of the 'Porcupine' (No. 3*a*, *antea*), and with that which was obtained by Mr. Gassiot from the Caribbean Sea, which I examined microscopically and of which I made an accurate drawing. The detail of the skeleton in *F. facunda*, represented in Schmidt's pl. i. figs. 13–17, also corresponds with that of the specimens mentioned; while the scopuline form (fig. 18) is often found modified in *Aphrocallistes Bocagei* (see our Pl. XV. fig. 3); and his rosette (fig. 19), with the exception of its arms and rays being microspined, together with the spino-capitate spicule (fig. 20), have their analogues in the rosette and umbrella-like spicules respectively of *Aulodictyon Woodwardii*.

Farrea occa, Bowerbank. Pl. XVI. fig. 4.

We now come to *Farrea occa*, which, as before stated, was so called from a fragment of lattice-like vitreous fibre that Prof. Owen found among the detrital mass on which Dr. A. Farre's specimen of *Euplectella cucumer* (obtained from the Seychelles) had grown. The structure of this fragment Prof. Owen figured (Trans. Linn. Soc. 1857, p. 121), and likened to a "harrow." Subsequently Dr. Bowerbank took a portion from the same detrital mass, and, having subjected it to a higher magnifying-power, thought that he had discovered in it a new kind of vitreous fibre, which was designated "fistulose siliceous," applying the name of "*Farrea*" to the sponge from which it was supposed to have come (Phil. Trans. 1862, p. 758, pl. xxviii. fig. 11). This was repeated in his 'British Spongiadæ,' where it was called "simple fistulose siliceous fibre spinulated, from *Farrea occa*" (vol. i. p. 274, 1864): *occa*, a harrow. Finally, in 1869 (P. Z. S. pl. xxiv. fig. 1) a different representation was given, in addition to the foregoing spinulated form, which was also now accompanied by certain minute spicules termed "attenuate stellate retentive spicula" of *Farrea occa* (*op. cit.* p. 341). These two representations,

viz. figs. 1 & 7, we shall find by-and-by to belong to two different species of *Farrea*, both figured previously and separately by Prof. Owen (*op.* et *loc. cit.* figs. 8 & 9 respectively); while Dr. Bowerbank's figure 7 alone represents *Farrea occa*, and the "retentive spicula" belong to quite another and very different system of sponges.

Now, considering that Dr. Bowerbank viewed fig. 7 as the "harrow-like tissue of the dermis" of some unknown sponge (instead of a part of the skeleton itself, which we now know to be the case)—that is, a portion of the wall itself of the tube of which *Farrea occa* is formed—considering that the term "fistulose" for the fibre, as being analogous to "simple keratose fibre" (B. S. vol. i. p. 80), ex. gr. *Luffaria*, is misapplied, inasmuch as it will presently be shown that the fistulous appearance in the siliceous fibre arises from the presence of sexradiate spicules, while in the keratose fibre it is a *bonâ fide* continuous canal—and considering that the "attenuate stellate retentive spicula" are not of the sexradiate type, but probably belong to an undescribed species of *Gummina* (see 'Annals,' 1873, vol. xii. p. 22), we have absolutely nothing left but the fragment of rectangular, vitreous, lattice-like fibre of this sponge, first represented by Prof. Owen's figures 9 & 9 *a* (*op. cit.*), and repeated in Dr. Bowerbank's figure 7 (P. Z. S. *l. c.*).

That, however, this rectangular lattice-like vitreous fibre has been identified with that forming the skeleton of a sponge to which Mr. Kent has applied the name of *Farrea occa* in his figures (*l. c.*), confirmed by my own observation, his delineations will show, and the specimen itself (now, Mr. Kent informs me, in the British Museum) will demonstrate. But there was nothing but the skeleton left, which, as before stated, was dredged up on the coast of Portugal filled with mud. Mr. Gassiot's specimen, of which I made an accurate drawing and microscopical examination, was in the same condition, and the specimen in "No. 3 *a*," dredged up on board H.M.S. 'Porcupine,' also the same; while Schmidt's figure of the specimen from Florida, which he examined (*op. et loc. cit.*), does not differ from either, and appears to have been also nothing but a deciduous skeleton, although it was accompanied by the spicules mentioned, and Schmidt has made a new species of it under the name of "*Farrea facunda*."

Since the above was written, I have (as before stated) examined Dr. A. Farre's specimen of *Euplectella cucumer*, entangled in the beard-like mass of which at the base (viz. the long anchoring-spicules) are many large fragments of *Farrea occa* (Pl. XVI. fig. 4), among which is a small portion of the

tubular general form, quite sufficient to identify with the specimens just mentioned,—also large fragments of the other or spiniferous species, represented by Dr. Bowerbank in his figure 1 (P. Z. S. *l. c.*), which will be described under the name of "*Farrea densa*" by-and-by.

Up to the present time, then, this is all we know of *Farrea occa*; but as there have been several specimens of its deciduous skeleton brought to notice, as well as many of *Aphrocallistes Bocagei*, with the so-called "fistulose" character in the fibre of all, it was not safe to state that all did not belong to the same genus, viz. *Farrea*. Under these circumstances there would be no hope of solving the problem, had it not been found that, although in the fresh and living state of the sponge hardly any trace of the spicules in the vitreous fibre can be seen, yet after death a process of absorption takes place in the interior of the fibre, whereby, if it has not gone too far, the whole of the forms of these spicules may be recognized. Hence, if any peculiarly characteristic spicules should happen to be present in this fibre, the species of the sponge to which it belonged can be determined, as in the case of the Aphrocallistidæ; while in *Farrea occa*, where we have never had any thing but the bare deciduous skeleton, the spicules which it possessed in the *living state* might, under the same circumstances, be also discovered. It is to this process of absorption and its effects in the sponge-spicule as well as the vitreous fibre that we shall now more particularly direct our attention.

Taking first the siliceous sponge-spicule by itself, we find that it is subject to two kinds of wasting or decay, viz. one which takes place in the interior or wall of the central canal, and the other on the surface—the former frequently occurring in the living sponge, and the latter in the substance of the spicule after death.

The wasting which takes place in the wall of the central canal is recognized by its increasing size, which in some cases goes on until the spicule is reduced to a mere shell; or it may take place only at the ends of the spicule, when the central canal at these points presents a funnel-shaped cavity diminishing inwards or towards the centre of the spicule. In either case the cause is not apparent. As this occurs in the living state it is just possible that the central canal of the spicule, which begins in a simple cell, may sometimes become so dilated as to assume the form of a full-grown spicule, with little if any vitrification, and thus appear as the mere shell. To this may be added a general absorption of the proper spicule, which frequently takes place within the horny fibre of

the keratose sponges to such an extent as often to render it very difficult to determine what was its original form.

On the other hand, the destruction which takes place on the surface of the spicule and extends into its substance presents itself under three different phases (Pl. XVI. fig. 8): viz., first, it consists of a simple superficial circular concavity, which may increase in size and depth (fig. 8, *a*); second, of a simple, straight, uniform blind tube extended vertically into the substance of the spicule (fig. 8, *b*); and, third, of a smaller tube of the same kind ending in a globular dilatation (fig. 8, *c*). In each instance it seems to be produced by the eroding action of an organized cell; that is, in specimens of the two latter, mounted in Canada balsam, a granuliferous cell may be observed to occupy the inner extremities respectively (fig. 9, *a*, *b*, *c*), recalling strongly to mind the appearance of the saprolegneous cell *Pythium* when working its way through the cell-wall of *Spirogyra*. Kölliker gives good figures of the first and second forms of this, merely observing that it is a "peculiar degeneration" ('Icones Histologicæ,' der feinere Bau, p. 83, pl. viii. fig. 10).

It is the dimpled superficial kind of this destruction which, attacking the deciduous spicule, seems not only to destroy the ornamental parts but in many instances to reduce the spicule to a mere ragged stick-like state, in which its original form is no longer recognizable: hence the condition of a great number of the fossil spicules in the Upper Greensand deposit of Haldon Hill near Exeter (Annals, 1871, vol. vii. p. 113, pls. vii., viii., & ix.).

I may here also notice that the calcareous sponge-spicules are also subject to two kinds of destruction, viz.:—one which takes place in the living sponge, where the extremities of the acerate long spicules are rendered funnel-shaped, as before mentioned in the siliceous ones; and the other, in which there is a general breakdown of the whole fabric, which gradually becomes resolved into a group of aqueous-looking globules of different sizes, among which there is not a trace of the original structure to be seen. Were this change confined to those calcareous spicules which I have mounted in Canada balsam, I should have inferred that it was caused by the balsam; but I find that the same change accompanies these spicules where they may have been taken in by the kerataceous sponges to form an axis for their horny fibre; and it is worthy of remark that the spicules of the Echinodermata, which may lie side by side with them, do not appear to be similarly affected. Of what nature the origin of this disorganization may be I am ignorant; it is a chemical question; but the destruction takes

place so rapidly in many instances that I have for some time past ceased to mount any more calcareous spicules, and now preserve a record of them by immediate sketches.

Lastly, we come to the peculiar kind of destruction to which I have so often before alluded, which takes place in the centre of the vitrified fibre of the Hexactinellidæ apparently *only* after the death of the sponge. This also, as before stated, consists in an absorption of the spicules over which the vitreous fibre was originally deposited, together with a certain amount of the fibre itself, leaving nothing but their moulds, which, if the absorption has not gone too far, will present exact representations of the spicules respectively. It is analogous to that which takes place in the spicules of the keratose sponges above mentioned.

We have here then an explanation of Dr. Bowerbank's "fistulose siliceous fibre," also a proof that the siliceous fibre of the Hexactinellidæ is based upon the spicules of the sponge, and, finally, means of detecting what the isolated spicules of the sponge were, although nothing may be left but the vitreous fibre in a deciduous state. It is thus that specimens of *Aphrocallistes Bocagei* have been identified, and some of those possessed by *Farrea occa* in its living condition recognized—facts which first drew my attention to the subject, originated this contribution, and will now be severally described.

The first specimen that attracted my notice in this way was the bunch of *Aphrocallistes* in the British Museum, already stated to have been dredged up by Mr. Kent on the coast of Portugal; but possessing the feature which had led Dr. Bowerbank to the idea that there existed "fistulose siliceous fibre" as well as "fistulose keratacеous fibre," and that this was an especial characteristic of his *Farrea occa*, I at once concluded that this was not an *Aphrocallistes*, but a *Farrea* (Pl. XVI. fig. 1).

Soon, however, it became evident that this "fistulose" appearance arose from the presence of sexradiate spicules originally enveloped in the vitrified fibre (fig. 1, *b b*); and chancing to meet with a fragment in which the characteristic scopuline shaft of *Aphrocallistes Bocagei* was present (fig. 2, *b*), the origin of the fistulose appearance was explained, and the specimen, which otherwise bore the character of *Aphrocallistes*, shown to be not *Farrea*, but *Aphrocallistes Bocagei* with the same fistulose appearance as the fibre of *Farrea* (fig. 4). Hence the necessity, to which I have alluded, of a minute and accurate description of all the spicules of these sponges.

Subsequently the specimen dredged up on board H.M.S. 'Porcupine' at station "No. 36" (*vide antea*) came before

me; and being exactly like Mr. Kent's, there was no difficulty in recognizing its specific nature; but on boiling a portion of it in *liquor potassæ*, it was also found to possess the characteristic scopuline shaft (Pl. XV. fig. 1) together with a rosette (fig. 11, *d*), both in great abundance in the mud with which the tubular branches of the sponge were still filled, especially towards their free closed extremities. It was then observed in the mounted specimen that there were also a few rosettes with elongated shaft-like axes, on which the rays were sometimes capitate and sometimes pointed, the latter bearing a strong resemblance to the spined shafts peculiar to *Aphrocallistes beatrix* (Pl. XIII. figs. 17 & 18). The presence of the rosette in these two forms being new to me, I turned to the examination of the type specimen of *Aphrocallistes Bocagei* in the British Museum, described and figured by Dr. Wright (*l. c.*), and found that it also contained the same kind of rosettes. Lastly, I examined *Aphrocallistes beatrix* in the British Museum, described and figured by Dr. Gray (*l. c.*), and found that, although this did not contain the globular rosette with *short* axis so abundant in *A. Bocagei*, it contained that form with elongated shaft-like axis in which the rays are occasionally capitate (Pl. XIII. fig. 19), thus so far retaining this character of *Aphrocallistes Bocagei*. Hence, again, the necessity of studying minutely all the spicules of these sponges, which led me to write the descriptions of them above given. It will now be observed that, in order to arrive at an accurate knowledge of the Spongiadæ structurally, they must be studied elementarily in this way, and upon the amount of this knowledge will depend the accuracy of our classification.

I next took some minute portions from the fragment which Mr. Kent sent me of his *Farrea occa*, and also from Mr. Gassiot's before mentioned, but was not correspondingly fortunate here. However, on returning to the deep-sea specimen dredged up on board H.M.S. 'Porcupine' (No. 3 *a*), which had grown on a *Lophohelia* and had subsequently been enveloped in a Gummina (*Corticium abyssi*), I found in one fragment, as the illustration will show (Pl. XVI. fig. 5), a spicule of the form no. 2 (Pl. XV. fig. 8) previously described under *Aphrocallistes Bocagei*. This spicule, as I have before stated, is not confined to *A. Bocagei*, but is found in *Aulodictyon Woodwardii*, *Hyalonema*, and all the sarcospiculous Hexactinellidæ possessing the "birotulate spicule." Possibly it might be considered an accidental instance, and therefore might not originally have belonged to *Farrea occa*; but in three or four instances it was found thus imbedded.

In each of two other fragments from this specimen of

Farrea occa a scopuline spicule with pointed rays was found, like that figured by Schmidt in his *Farrea facunda* (*l. c.*). These specimens were also mounted in Canada balsam and delineated, as the illustrations will show (Pl. XVI. figs. 6, *b*, & 7, *b*).

Lastly, in many instances in the fibre of *Farrea occa* the capitate end of a largish spicule was observed (fig. 7, *c*), which I see appears in one of Schmidt's *fossil* illustrations (*op. cit.* pl. ii. fig. 18) as an arm of a sexradiate spicule. Of this form I can state, as I know, nothing further.

I had hoped, by finding this specimen of *Farrea* enveloped in the Gummina, that I might also find some of its isolated spicules within the tube; but, with the exception of four sexradiates of the form no. 3 under *Aphrocallistes Bocagei*, viz. that with the feather-like spined arm (Pl. XV. fig. 9), I could not, even after repeated searching, see any thing of the kind.

Whether or not these spicules did belong to *Farrea occa* I am unable to state, since together with the *Farrea* were included in the Gummina some fragments of *Aphrocallistes Bocagei*, one of which, as will be seen by the illustration, bears a mould of the sexradiate spicule with feather-like arm just mentioned. That such spicules are involved in the vitreous skeleton of this sponge has been already shown by the embryonic specimen mentioned at p. 452.

In the "stick-like" fragment among Mr. Gassiot's specimens, also above noticed, which looks like the solid stem of *Farrea infundibuliformis*, the absorbing process has gone on to such an extent internally as to destroy all forms of the sexradiate spicules on which the vitreous fibre of which it is composed was built, and externally to such a degree as to round off and diminish in size every spine and original projection of this fibre; so that it now presents the white appearance and form of a substance that is disappearing under the dissolving influence of water. Such is another instance of the way in which the fibre of the hexactinellid sponges may pass into dissolution.

We learn from the foregoing, then :—

1st. That the vitreous structure of the Hexactinellidæ is built upon a network of their spicules, as proved by the examination of the embryonic forms of *Aphrocallistes Bocagei*, in one of which (viz. that $\frac{1}{244}$ of an inch in diameter) the process of vitrification has not commenced, while in the other ($\frac{2}{172}$ of an inch in diameter), although incomplete, it has already made considerable progress; that after the spicules have become enveloped in the vitrification their forms disappear; and that,

finally, after the fully developed fibre has become deciduous, their forms reappear in the state of moulds caused by a process of absorption of the spicule not yet explained.

2nd. That by the reappearance of the forms of the spicules we are enabled to determine the species if previously known in a living state, although nothing but the bare deciduous vitrified structure may remain; and therefore, where no living specimen of the species has been found, to determine what kind of spicules it originally possessed.

3rd. That there are no grounds for stating that a hexactinellid sponge exists in which the fibre is fistulous—that is, pervaded by a continuous central canal, as in the keratose sponge *Luffaria* (D. et M.); but, on the contrary, that the vitreous fibre is always based on an axis of sexradiate spicules.

With the deciduous specimens of *Aphrocallistes Bocagei* there has been no difficulty in determination, because we know what the characteristic spicules of this sponge are in its living state.

But the case is not so satisfactory with *Farrea occa*, of which nothing but deciduous specimens have yet been found. However, here it is evident that, besides the common sexradiate spicules of the skeleton (Pl. XVI. fig. 4, *b b b*), there was the spined one described as no. 2 under *Aphrocallistes Bocagei* (fig. 5, *b*), and the scopuline shaft like that figured by Schmidt in his *Farrea occa* (figs. 6, *b* & 7, *b*), to which I have before alluded.

Lastly, it might be stated respecting *Farrea occa* that, although we know that, in addition to the common sexradiates, it possessed the spined spicule no. 2 of *Aphrocallistes Bocagei* and another like the scopuline spicule of *Farrea facunda*, while the latter spicule is by no means identical with that figured by Schmidt (neither have we seen the spino-capitate spicule nor the rosette which are also figured by the same author as characteristic of *F. facunda*), yet the field from which we have obtained the facts above mentioned respecting *F. occa* is very limited; so that by-and-by, if a living specimen is not found of *F. occa*, but still more deciduous ones, more of the spicules it originally possessed may be made known after a like manner. At the same time, it should be remembered that the *general* figure (Taf. ii. fig. 10), as well as the detail of its skeleton which Schmidt has given of his *F. facunda*, are so identical with Mr. Kent's, Mr. Gassiot's, and the deep-sea ones of *F. occa* before mentioned that without a certain knowledge of all the isolated spicules of the latter it would be very hazardous to state that *F. occa* and *F. facunda* were not one

and the same species. Should this turn out to be the case, which name is to be suppressed?

That Schmidt's specimen of *F. fucunda* was a deciduous one is proved (if I am right in considering that the reappearance of the sexradiate spicules (Pl. XVII. fig. 4) *only* takes place after death) by his description and delineations, wherein he both states and shows that the vitreous fibre was built upon sexradiate spicules, and also shows that the specimen which was submitted to him for examination was accompanied by the isolated forms of spicules peculiar to the species, which he has also represented; so was the deciduous specimen of *Aphrocallistes Bocagei* "No. 36" dredged up on board H.M.S. 'Porcupine,' although not that dredged up on board the 'Norna' by Mr. Kent, of which nothing was left but the vitreous structure.

It will be remembered that at p. 446 I have stated that Dr. Bowerbank had confounded two species of *Farrea* in his illustrations of *F. occa* (P. Z. S. 1869, pl. xxiv. figs. 1 & 7); also that both had been previously noticed and illustrated by Prof. Owen in 1857 (Trans. Linn. Soc. *l. c.*); further that the "retentive spicules" figured by Dr. Bowerbank as characteristic of *Farrea occa* do not belong to the sexradiate system of sponges, but probably to some undescribed species of *Gummina*.

In order that I might fully satisfy myself of these points I (at the kind suggestion of Dr. Farre) took for deliberate examination fragments of these two species of *Farrea*, which abound, in a deciduous state, in the mass of detrital material in which the anchoring-spicules of his specimen of *Euplectella cucumer* are imbedded. These, which altogether would not fill a cubic space of $\frac{2}{7}$ inch, were boiled in nitric acid; and the larger fragments having been taken out, the rest was well washed, dried, and mounted in Canada balsam. To a short description of the latter I shall return presently; in the mean time let us turn our attention to the specimens of the two *Farreæ*; and as already *F. occa* has been described, we have now only left the new species which stands in Prof. Owen's and Dr. Bowerbank's illustrations respectively under the figures "8" and "1." To this species I intend to apply the term "*densa*," on account of its massive reticular structure, which is just the opposite to that of *Farrea occa*, whose general form is tubular, branched, and only one layer thick. While, however, nothing remains of this sponge also but its deciduous skeleton, still the general character of this and the peculiar character of the fibre of which it is composed appear to me, although necessitating a very short de-

scription, to be quite sufficient to show that it is a distinct species.

Farrea densa, n. sp. (Pl. XVII. figs. 5 & 6.)

Skeleton composed of lattice-like, subrectangular, thickly spined, vitreous fibre, varying in size with its age, anastomosing freely in all directions, so as to form a densely reticulate massive structure. Fibre originally based on sexradiate spicules, whose forms have become more or less recognizable by the process of absorption above mentioned; thickly spiniferous, each spine conical and divided at the summit into several spinules, which are expanded (fig. 6, *b b b*).

Hab. Marine.

Loc. Seychelles.

Obs. There are many large detrital fragments of the deciduous skeleton of this sponge mixed up with those of *Farrea occa*, and a host of other matters, all entangled in the tuft of anchoring-spicules at the base of Dr. A. Farre's specimen of *Euplectella cucumer*; but none appear to indicate the general form of the sponge to which they belonged, while they are accompanied by such a variety of minute spicules of all kinds that it is impossible to state which, if any of them, formed part of their original structure.

Among the spicules boiled off from these minute fragments and mounted in balsam, as before stated, may be observed:—a new form of equianchorate, very large, with both ends of the shaft winged or spread out laterally by a thin expansion like that on the shaft of the anchorate in the deep-sea sponge called by the late Dr. M. Sars "*Cladorhiza abyssicola*" ('Remarkable Forms of Animal Life from the Great Deeps on the Norwegian Coast,' by the late Dr. M. Sars, edited by his son, p. 65, pl. vi. f. 32: Christiana, 1872); several kinds of bihamate spicules, among which is one sparsely spined on the body and measuring 23 1800ths of an inch long by one 1800th of an inch in its thickest part (this is the largest known, being more than twice the size of that in the deep-sea sponge just mentioned, viz. *Cladorhiza abyssicola*, which with another similar sponge, viz. *Chondrocladia virgata*, Wy. Thomson, were abundantly dredged up on board H.M.S. 'Porcupine'); three distinct forms of siliceous globules, indicating as many species of *Geodia*; one discoid from *Stelletta mammillaris*, Sdt. (?); the scopuline shaft of *Aphrocallistes beatrix* in great abundance; spicules of undescribed species of Gummineæ, especially that figured by Dr. Bowerbank (P. Z. S. 1869, pl. iii. figs. 6 *a* & 16) as belonging to "*Dactylocalyx pumiceus*, Stutchbury"! the surface-spicule of two different kinds of Lithistidæ, and frag-

ments of a new species which I am about to describe under the name of *Arabescula parasitica*, together with exquisite skeletons of many Polycystinæ and circular frustules of Diatomaceæ, &c. In short, I should think that a careful examination of this mass of detritus, after the manner mentioned, would, if furnishing an amount of deciduous remains proportional in number and variety to that which came from the minute fragments of the *Farrea* that I boiled in nitric acid, yield sufficient not only to copiously illustrate a book with most exquisite figures, but to afford no mean catalogue of the sponge-fauna, Polycystinæ, and marine Diatomaceæ of that part of the Seychelles from which this specimen of *Euplectella cucumer* was obtained.

Lastly, I have to describe the structure of a new genus of sponges, apparently allied to the Lithistidæ, which was first observed on some fragments of the deciduous skeletons of *Aphrocallistes Bocagei* and *Farrea occa* respectively, from the specimen No. 3 *a* dredged up by H.M.S. 'Porcupine,' and subsequently seen among the minute spicules &c. just mentioned which were boiled off the fragments of the two *Farreæ* from the root-mass of *Euplectella cucumer*. The resemblance of this structure, which lies flat and parasitic on the deciduous glassy fibre mentioned, to that kind of sculptured "open work" used by the Mohammedans for their architectural windows before glass was made for this purpose, suggests the generic name of "*Arabescula*"—and the manner in which it has grown over the deciduous fibre mentioned, the specific "*parasitica*;" under which appellation it will now, so far as the bare skeleton permits, be described:—

ARABESCULA, nov. gen., Carter.

Arabescula parasitica, n. sp., Carter. (Pl. XVII. figs. 7–9.)

Skeleton corticiform, vitreous, thin, spreading, composed of frond-like spicules, each of which is formed of a sinuous, vermicular body, tortuously branched in all directions on the same plane (fig. 8, *a*); branches ending in filigreed terminations, which, interlocking with those of adjoining fronds, constitute a membrane-like expansion (fig. 7, *b*). Body smooth externally, provided with sparsely scattered, short, truncated cylindrical projections (fig. 8, *b*) on the inner side, which, being situated on the body and larger branches, rested on the vitreous fibre over which the sponge might be growing.

Hab. Marine, growing over deciduous fibre of *Aphrocallistes Bocagei* and *Farrea occa*.

Loc. Western entrance of the English Channel; and the sea about the Seychelles.

Obs. This exquisite little arabesque structure (Pl. XVII. fig. 7, *b*), from its vitreous appearance, and from not dissolving when boiled in nitric acid, together with the form of its frond-like branched and filigreed spicules (fig. 8, *a a*), seems to belong to the Lithistidæ; but, like the preceding species of *Farrea densa* as well as *F. occa*, it has yet to be found in a living state for this identification, and for the remaining part of its description. While some portions are found on the vitreous fibre of the sponge mentioned, others are observed to be separated from it (fig. 9), as if the extent to which the structure had grown round the spicule and had formed by union a continuous sheath had determined this. It appears to be the product of a creeping sarcode, like that of the Spongiadæ; and therefore I assume for the present that it is the structure of a sponge.

EXPLANATION OF THE PLATES.

Plate XIII.

Hexactinellidæ.

Skeleton-spicule.

Fig. 1. Three small skeleton-spicules, showing the way in which they are united to the main fibre and to each other to form the skeleton-structure: *a*, fragment of main fibre; *b*, small skeleton-spicule united by one arm to the fibre; *c c*, skeleton-spicules united by one arm to the spicule *b*. From *Aphrocallistes Bocagei.*

Flesh-spicules.

Fig. 2. Rosette with long arms and short, straight, pointed, dual rays: *a a a a a a*, arms; *b b b b b b*, rays. From *Crateromorpha Meyeri*, Gray.

N.B. After this the fifth and sixth arms (*c c*), or third axis, will, for the sake of perspicuity, be omitted.

Fig. 3. Rosette with short arms and long, straight, pointed rays. *Euplectella aspergillum.*

Fig. 4. Rosette with three-rayed arm. *Euplectellidæ.*

Fig. 5. Rosette with two-rayed arm; rays straight, capitate, few- and long-spined: *a*, caput or head; *b*, head, more magnified, to show spines, end view; *c*, the same, lateral view. *Rossella velata*, Wy. Thomson.

Fig. 6. Rosette with *short* arms and many straight capitate rays: *a*, many-spined head, end view; *b*, the same, lateral view. *Dactylocalyx subglobosa*, Gray.

N.B. This is the usual form of head, although the spines may not always be distinguishable except with a very high power.

Fig. 7. Rosette with *long* arms and many straight capitate rays. *Dactylocalyx subglobosa*, Gray.

Fig. 8. Rosette with multitudinous straight rays of unequal length, capitate. *Crateromorpha Meyeri.*

This is the rosette to which I have applied the term "pappiform," with straight capitate rays.

Fig. 9. Rosette with many sigmoid capitate rays arranged *en fleur-de-lis*, expanded. *Farrea infundibuliformis.*

Fig. 10. Rosette with many sigmoid capitate rays arranged *en fleur-de-lis*, contracted below only. *Myliusia callocyathes.*

Fig. 11. Rosette with many sigmoid capitate rays arranged *en fleur-de-lis.* Ray clavate; head expanded laterally and dentate outwardly, claw-shaped; diminished to extreme fineness just before it terminates in the lower fourth, which again becoming thicker joins the end of the arm of the rosette: *a*, upper portion of ray, more magnified, dorsal view; *b*, the same, lateral view. *Euplectellidæ.*

Fig. 12. Rosette with multitudinous sigmoid rays of unequal length, without heads, arranged *en fleur-de-lis.* Ray linear, subulate; upper portion thick and bent downwards and outwards at the end; diminishing below into extreme fineness just before it terminates in the lower fourth, which again becoming thicker joins the end of the arm of the rosette. *Rossella velata*, Wy. Thomson.

N.B. The extreme fineness to which the ray is reduced at the point mentioned often leads to its being broken off in the two rosettes last described, whereby it is seen lying about the "field" in the forms of 11 *b* and 15 *a* respectively, while the lower extremities still remain attached to the arm of the rosette, as at 15 *d*.

Fig. 13. Rosette with rays once branched, capitate. An occasional form. *Dactylocalyx subglobosa.* *a*, echinated head of ray; an occasional form of the head in fig. 6, from the same sponge.

Fig. 14. Rosette with straight capitate rays spined laterally. *Euplectella aspergillum* (fragment dredged up by H.M.S. 'Porcupine').

Fig. 15. Rosette; more magnified view of one arm of fig. 12: *a*, detached ray, broken off at the fine portion; *b*, conically inflated and tubercled end of arm; *c*, apical straight spine of the same; *d*, end of arm, showing the way in which the lower extremities of the rays still remain attached to the tubercles on the inflation after the upper portions (*a*) have been broken off.

Fig. 16. Rosette; more magnified view of one arm of fig. 8: *a*, rays, of unequal length; *b*, conically inflated and tubercled end of arm; *c*, end of arm, showing the way in which the straight rays are respectively based on a tubercle.

Fig. 17. Rosette with elongated shaft-like axis and straight capitate rays. *Aphrocallistes Bocagei.*

Fig. 18. Rosette with elongated axis and pointed rays. *Aphrocallistes Bocagei.*

N.B. The last two forms are rather sparsely mixed up with the globular forms figs. 6 & 7 in *Aphrocallistes Bocagei.*

Fig. 19. Rosette with elongated axis and straight pointed rays, often capitate. *Aphrocallistes beatrix.*

Fig. 20. Long-spined shaft peculiar to *Aphrocallistes beatrix.*

This and the foregoing form are mixed up together in *A. beatrix* without the forms 6 & 7, which are only found in *A. Bocagei.* They bear the relation in size represented in the figures (19 & 20); but 20 is much more plentiful than 19. Thus, while the forms 6 & 7 appear to pass into 17 & 18 in *A. Bocagei*,

fig. 19 (which is identical with the latter) appears to be a transitionary form to fig. 20, which is the long-spined spicule peculiar to *A. beatrix*.

N.B. The dotted lines indicate that the spines themselves are microspined. Figs. 18–20 are all on the scale of 1-12th to 1-6000th of an inch.

Flesh-spicules of Hyalonema, &c.

Fig. 21. Birotulate, consisting of a sparsely spined straight shaft, terminated at each end by eight separate blades, which are recurved, dome-shaped towards the centre. *Hyalonema Sieboldii*, Gray, &c.

Fig. 22. Birotulate in a sexradiate form, showing its analogy to the "rosette." *Hyalonema Sieboldii*. Sparse.

N.B. The birotulate may have two, four, or six heads, according with the development of the elementary cell of the spicule into two, four, or six arms—that is, a simple shaft, a cross, or sexradiate.

In like manner, the rotulate heads may be absent, and the shafts thickened and covered with short, conical, vertical spines either at the extremities only or throughout (see Bowerbank's Brit. Spong. vol. i. pl. vi. figs. 153–157).

Fig. 23. Rosette with straight pointed rays, in which the arms have become enveloped by vitrified sarcode so as to form a spherical centre. *Euplectella cucumer*.

Fig. 24. Rosette with straight capitate rays, in which the same thing has taken place, but the vitrified mass has gone beyond the arms of the rosette: *a*, main fibre; *b*, portion uniting rosette to main fibre. *Dactylocalyx pumiceus*.

N.B. The last two forms point out the transition of the rosette to the siliceous globules and stellates (which are also "flesh-spicules") in the Geodinidæ, &c.; while the junction of this rosette with the main fibre is the *only* instance in which I have met with a flesh-spicule involved in the skeleton-structure.

Plate XIV.

Anchoring-spicules.

Fig. 1. Spiniferous anchoring-spicule of *Labaria hemisphærica*, Gray, showing form of head or free end: *a*, head; *b*, undulating line on head, which has its projecting curves prolonged into spines in *Euplectella* (see figs. 4 & 5); *c*, portion of shaft, whose upper or fixed end is smooth and attenuated; *d*, spines on shaft; *e*, position of cross on central canal.

Fig. 2. *Smooth* anchoring-spicule of *Labaria hemisphærica*, showing form of head or free end: *a*, position of cross; *b*, usual inflation of shaft just before expansion into head (here there is no undulating line on the head, which is more or less compressed); *c*, portion of the smooth shaft.

N.B. These two forms in *Labaria* are relatively magnified and taken from the larger specimens of their kind. The upper or fixed end of the shaft is not figured, neither is the intervening portion between it and that given; but the former is the same in all the anchoring-spicules, viz. smooth, attenuated, and firmly fixed in the sarcode of the body; while the latter or intervening

portion is spiniferous in the spined and smooth in the smooth anchoring-spicules.

Fig. 3. Spiniferous anchoring-spicule of *Meyerina claviformis*, Gray, showing form of head or free end: *a*, position of the cross; *b*, undulating line.

The only difference between this and the spiniferous anchoring-spicule of *Labaria* consists in the prominence and number of the undulations of the line on the head, too slight for specific distinction, although showing still more strongly that these undulations are prolonged into spines in *Euplectella*. Figs. 1–3 are all on the scale of 1-24th to 1-1800th of an inch.

Fig. 4. Spiniferous anchoring-spicule of *Euplectella aspergillum*, showing form of head or free end, where the spines or arms are lateral and much recurved: *a*, undulating line; *b*, end of central canal terminating in a lash of branches; *c*, position of the cross on central canal.

Fig. 5. The same, in which there are eight spines or arms uniformly arranged round the head, and based respectively upon the projections of *a*, the undulating line; *b*, position of the cross on the central canal.

Figs. 4 and 5 are on the scale of 1-12th to 1-1800th of an inch.

Fig. 6. Spiniferous anchoring-spicule of *Holtenia Carpenteri*, showing form of head or free end: *a*, position of the cross on the central canal. Here there is no undulating line, on account of the thinness of the head. Scale 1-24th to 1-1800th of an inch.

Fig. 7. Portion of the shaft of a spiniferous anchoring-spicule of *Holtenia Carpenteri*, showing the distant but still spiral arrangement of the spines: *a*, proximal end; *b*, spines; *c c c*, spines, made a little lighter to represent their being on the *opposite* side of the shaft.

Fig. 8. Portion of the shaft of a spiniferous anchoring-spicule of *Meyerina claviformis*, showing a more crowded, but still spiral, arrangement of the spines: *a*, proximal end; *b*, spines; *c c c*, spines on the opposite side of the shaft.

Fig. 9. Portion of the shaft of a spiniferous anchoring-spicule of *Hyalonema Sieboldii*, Gray, showing a still more crowded condition of the spines, which are here grouped into lines arranged round the shaft more or less in a continuous spire; also that they are supported on bracket-like projections of the shaft: *a*, proximal end; *b*, spines; *c c c c*, spines on the opposite side of the shaft; *d*, groups in continuous spiral; *e*, minute tubercles or aborted spines; *f*, spines broken off.

N.B. The specimen of *Hyalonema* from which this drawing was made was dredged up on board H.M.S. 'Porcupine' in the Atlantic Ocean, somewhere off the coasts of Great Britain and Ireland. The body is just 1½ inch long, and the thickness of the spicule of course very small compared with that of an adult form, which, if relatively magnified, would exceed the whole width of the plate. Moreover the portion selected for mounting and drawing was taken *out of* the *body* and not from the stem, where the spines soon get rubbed off, although they may be afterwards frequently found lying on the shaft, as at *f*. The minute tubercles *e*, often accompanying the groups of spines, are the remains of such as never went beyond this stage of development, as the whole group of spines and tubercles commences in this way in the upper part of the anchoring-spicule

(viz. that enclosed within the body), diminishing upwards into nothing, and gradually passing into fully developed spines below.

Figs. 7–9 are on the scale of 1-12th to 1-1800th of an inch.

Fig. 10. Fragment of *Euplectella cucumer*, to show robust vertical spine of sexradiate spicule in the intervals between the circular openings: *a a a*, spines; *b b*, circular openings; *c*, lines of main spicules crossing each other. Diagrammatic.

Plate XV.

Sub- skeleton spicules of the Aphrocallistidæ *and* Aulodictyon. (By "sub-skeleton" are meant the subordinate, not the staple, skeleton-spicules.)

Fig 1. Scopuline spicule of *Aphrocallistes Bocagei*: *a*, head; *b*, shaft; *c*, sexradiate tubercle-inflation of neck; *d*, variety in which the shaft is somewhat extended beyond the inflation.

Fig. 2. Scopuline spicule of *Aphrocallistes beatrix*.

Fig. 3. Scopuline spicule of *Aphrocallistes Bocagei*. Occasional variety. Like the one in Schmidt's *Farrea facunda* (*l. c.*).

N.B. The dotted lines indicate that the parts are microspined. Such is the case also with the ends of the shafts, which are here represented with smooth lines.

Fig. 4. Spino-capitate shaft or spicule of *Aulodictyon Woodwardii*; head umbonate, many- and small-spined. *a*, the same, with head plano-convex or plain, not umbonate.

Fig. 5. Spino-capitate shaft or spicule of *Aulodictyon Woodwardii*; head umbonate, spines few, and microspined on the inner aspect. *a*, the same, with plano-convex head.

N.B. These two forms appear to be the extremes of the same spicule, which are united by a variety of transitionary ones. Figs. 1–5 are on the scale of 1-12th to 1-6000th of an inch.

Fig. 6. Nail-like skeleton-spicule of *Aulodictyon Woodwardii*, to show the way in which the four arms are accompanied by the spino-capitate spicules, with which they become included in the vitreous fibre (as shown in the following figure): *a*, shaft of nail-like spicule; *b*, arms; *c*, spino-capitate spicules. Diagrammatic.

Fig. 7. Portion of the vitrified fibre of *Aulodictyon Woodwardii*, showing that the spino-capitate spicules are included with the arms of the nail-like spicules in the vitrified skeleton: *a*, vitrified fibre; *b*, head of spino-capitate spicule, whose shaft is enclosed in the fibre; *c*, end of arm of nail-like spicule not enclosed. Scale 1-12th to 1-6000th of an inch.

Fig. 8. Fusiform spiniferous spicule, in which all the spines incline the same way. Common to the Aphrocallistidæ, *Aulodictyon*, and *Farrea occa* (see Pl. XVI. fig. 5); also to all the Hexactinellidæ possessing the birotulate spicule.

Fig. 9. Sexradiate spicule with one arm spined, feather-like. Common to the Aphrocallistidæ, *Aulodictyon*, *Sympagella nux*, and the Hexactinellidæ which possess the birotulate spicule. Scale 1-24th to 1-6000th of an inch.

Fig. 10. Sexradiate spicule in which each arm is more or less uniformly beset with long curved spines. *Aphrocallistes beatrix*, Euplectellidæ, and the Hexactinellidæ possessing the birotulate spicule.

The figure represents an unusually perfect form, as regards the

uniformity of spines, from *Aphrocallistes beatrix*. Scale 1-24th to 1-6000th of an inch. In general, it is a very ragged-looking half-developed spicule.

Fig. 11. Portion of the commencing vitrification of the skeleton in a young *Aphrocallistes Bocagei*, not more than two twelfths of an inch in diameter, showing the enclosure of the sexradiate with spined feather-like arm among the other spicules; also the characteristic rosette: *a a*, spicules with feather-like arm; *b b*, other spicules; *c c*, vitrified sarcode spreading over the same; *d*, form of rosette. Scale 1-24th to 1-6000th of an inch.

N.B. This appears to be Schmidt's *Lanuginella pupa*. It is found growing on a branch of *Lophohelia prolifera* close to a living *Aphrocallistes Bocagei*, just as Schmidt has represented it growing in abundance on *Aphrocallistes Bocagei* itself (Atlantisch. Spongienf. pl. ii. fig. 1). It can only be confounded with the structure of *Sympagella nux*, Sdt., whose characteristic ladder-like vitreous fibre and the pappiform rosette, however, point out the distinction.

Plate XVI.

Deciduous vitrified fibre.

Fig. 1. *Aphrocallistes Bocagei*. Fragment of dead specimen dredged up from muddy bottom at the western entrance to the English Channel, in 725 fathoms, by H.M.S. 'Porcupine,' showing that the fibre is based on sexradiate spicules whose presence is rendered evident, after the fibre has become deciduous, by a process of absorption which, if not gone too far, leaves a perfect mould of the imbedded spicule. *a a*, spiniferous vitreous fibre; *b b*, moulds of spicules; *c c*, puncta indicating spines on the surface of the fibre.

This specimen, or the portions which were still filled with mud having been boiled in liquor potassæ, yielded an abundance of the rosette and scopuline spicule peculiar to *Aphrocallistes Bocagei*.

Fig. 2. *Aphrocallistes Bocagei*. Fragment of dead specimen dredged up from muddy bottom on the north-west coast of Spain, on board the yacht 'Norna' (depth not mentioned), showing an enclosure of the scopuline spicule in the vitreous skeleton (Pl. XV. fig. 1): *a*, spiniferous vitreous fibre or skeleton; *b*, scopuline spicule.

Although this specimen was treated with liquor potassæ in the way above mentioned, it yielded neither rosette nor scopuline spicule. Thus, but for the presence of the latter involved in the skeleton, there might have been (and indeed was) a doubt as to the species. Figs. 1 and 2 are on the scale of 1-12th to 1-1800th of an inch. The difference in size is owing to the difference in the size of the fibre in the two specimens figured.

Fig. 3. *Aphrocallistes Bocagei*. Fragment involved in the Gummina (*Corticium abyssi*) enveloping *Farrea occa*, which had grown on a dead *Lophohelia prolifera* dredged up from muddy bottom at the western entrance of the English Channel, on board H.M.S. 'Porcupine,' in 500 fathoms (see sketches of specimen, 'Annals,' 1873, vol. xii. pl. i. figs. 1 & 2), showing an enclosure of the sexradiate spicule with feather-like arm in the vitreous skeleton (Pl. XV. fig. 9): *a a*, spiniferous vitrified skeleton; *b*, sexradiate spicule with feather-like arm. Scale 1-12th to 1-1800th of an inch.

Fig. 4. *Farrea occa.* Fragment of deciduous skeleton from the last-named specimen showing that the smooth, lattice-like, subrectangular fibre is based on sexradiate spicules, as above mentioned : *a a a a*, lattice-like fibre, smooth ; *b b b*, moulds of sexradiate spicules ; *c c c*, short conical spiniferous extensions of the fibre, corresponding to the two arms of the sexradiate spicule, which projected vertically both inside and outside of the lattice-like structure. Scale 1-24th to 1-1800th of an inch.

Fig. 5. *Farrea occa*, fragment of, from the same specimen, showing an enclosure of part of a fusiform spined spicule in the vitreous fibre (Pl. XV. fig. 8) : *a a*, smooth vitrified fibre ; *b*, *un*imbedded half of fusiform spined spicule ; *c*, imbedded half of the same. Scale 1-24th to 1-1800th of an inch.

This spicule is common in the Aphrocallistidæ, *Aulodictyon*, &c.

Fig. 6. *Farrea occa*, fragment of, from the same specimen, showing the enclosure of a scopuline spicule with pointed rays, like that figured by Schmidt as occurring in his *F. facunda* : *a a*, smooth vitrified fibre ; *b*, mould of scopuline spicule (see a similar form found occasionally in *Aphrocallistes Bocagei*, Pl. XV. fig. 3).

Fig. 7. *Farrea occa*, fragment of, from the same specimen, showing the enclosure of another form of scopuline spicule with pointed rays ; also a capitate spicule of a larger kind, often observed : *a*, smooth vitrified fibre ; *b*, scopuline spicule ; *c*, capitate spicule, in which the head seems in some instances to be flattened ; the latter is introduced by Schmidt as an arm of a *fossilized* sexradiate spicule (tab. ii. f. 18, *op. cit.*).

Figs. 6 and 7 are on the scale of 1-24th to 1-6000th of an inch.

Fig. 8. Fragment of a large deciduous linear spicule (from *Geodia?*), to show the different forms caused by some eroding organism : *a*, simple circular depression ; *b*, straight tubular form ; *c*, the same, expanding into a globular termination in the substance of the spicule. Diagrammatic.

Fig. 9. The same, more magnified, to show that each of the forms is attended by a granuliferous cell something like the saprolegneous one (*Pythium entophytum*) which bores its way through the cell-wall of *Spirogyra*, &c. *a a a*, granuliferous cell.

Appears to be of general occurrence, as I have specimens from the Agulhas Shoal at the Cape of Good Hope, dredged up by Dr. Wallich, from the dredgings of H.M.S. 'Porcupine' off the north coast of Scotland, and from the Seychelles, among the detrital mass of the specimen of *Euplectella cucumer* in the possession of Dr. A. Farre, &c. &c.

Plate XVII.

New Species of Hexactinellidæ, &c.

Fig. 1. *Farrea infundibuliformis*, sp. n. *a*, funnel-shaped expansion ; *b*, stem ; *c*, reticulating lines of large, branching, vitreous fibre imbedding minute sexradiate spicules confusedly, fibre microspined ; *d*, distinct or accessory portion of small vitreous fibre imbedding the same regularly ; *e*, dotted line indicative of original expansion. Natural size.

Fig. 2. The same, portion of inner surface of funnel-shaped expansion,

more magnified, to show:—*a a a*, reticulating lines of large vitreous fibre imbedding *minute* sexradiates confusedly, running over and covering in part *b b*, spinous lattice-like fibre imbedding *large* sexradiates regularly; *c c*, puncta indicating microspines on large vitreous fibre; *d d*, minute sexradiates. Diagrammatic.

Fig. 3. The same, minute sexradiate, more magnified, showing that one end is united to the vitreous fibre: *a*, minute sexradiate; *b*, vitreous fibre.

Fig. 4. The same. Rosette or flesh-spicule, also more magnified. Figs. 3 and 4 are upon the scale of 1-48th to 1-6000th of an inch.

Fig. 5. *Farrea densa*, sp. n. Fragment magnified on scale of 1-48th to 1-1800th of an inch. From deciduous portions, upwards of an inch in diameter, in the detrital mass enveloped by the anchoring-spicules of *Euplectella cucumer* from the Seychelles.

Fig. 6. The same. Portion of vitreous fibre of, more magnified, to show that the summit of the spines is mucronate: *a a*, fibre; *b b b*, mucronate spines; *c c*, mould of sexradiate spicule. Scale 1-12th to 1-6000th of an inch.

Fig. 7. *Arabescula parasitica*, sp. n., parasitic on vitreous fibre of *Aphrocallistes Bocagei*: *a a*, fibre; *b*, portion of *Arabescula*. From the specimen dredged up on board H.M.S. 'Porcupine' in 500 fathoms, above mentioned; also from the detrital mass of *Euplectella cucumer* on the fibre of the foregoing species. Scale about 1-32nd to 1-6000th of an inch.

Fig. 8. The same. *Internal* view, showing that there are distinct fronds, *a a*, with projections, *b*, on the body and main branches here and there, which appear to have been based upon the fibre on which the *Arabescula* was parasitic.

Fig. 9. The same. Portion much less magnified, which appears to have become separated from the fibre on which it had been parasitic. Natural size about 1-18th of an inch long by 1-180th of an inch in widest part.

LV.—*Descriptions of New Genera and Species of* Heteromera, *chiefly from New Zealand and New Caledonia, together with a Revision of the Genus* Hypaulax *and a Description of an allied New Genus from Colombia.* By Frederick Bates.

As there is considerable activity just now displayed in the publication of papers descriptive of the coleopterous fauna of New Zealand, I have thought it might be acceptable to give descriptions of all the species of New-Zealand *Heteromera* contained in my collection that appear to be new to science.

I have therewith incorporated a revision, together with descriptions of new species, of my genus *Hypaulax* and another, allied, new genus (*Astathmetus*) from Colombia.

Of the genus *Cilibe* (peculiar to New Zealand) I have established twelve species (ten of which are new, the *phosphugoides*, White, = *elongata*, Brême) and two supposed varieties.